

CHEM 155A – Practice Exam II

Part I – Multiple Choice

1. In the α -helix the hydrogen bonds:

- ☒ A) are roughly parallel to the axis of the helix.
- ☐ B) are roughly perpendicular to the axis of the helix.
- ☐ C) occur mainly between electronegative atoms of the R groups.
- ☐ D) occur only between some of the amino acids of the helix.
- ☐ E) occur only near the amino and carboxyl termini of the helix.

2. The major reason that antiparallel β -stranded protein structures are more stable than parallel β -stranded structures is that:

- ☐ A) Parallel strands are in a less extended configuration than antiparallel strands.
- ☐ B) Antiparallel strands have as many disulfide crosslinks between adjacent strands.
- ☐ C) Parallel strands do not stack in sheets as well as antiparallel strands.
- ☒ D) Anti-parallel b-strands have linear hydrogen bonds between the strands.
- ☐ E) Parallel b-strands have non-linear hydrogen bonds between adjacent strands.

3. Which of the following is true regarding protein secondary structure

- ☐ A) It involves a combination of covalent and non-covalent bonds
- ☐ B) It involves hydrogen bonds to the peptide backbone and side chains
- ☐ C) It involves the hydrophobic effect
- ☒ D) It involves hydrogen bonds to the peptide backbone

4. In hemoglobin, the transition from T state to R state is triggered by:

- ☐ A) Fe^{2+} becoming Fe^{3+}
- ☐ B) heme expulsion from the active site.
- ☒ C) oxygen binding destabilizes an ion pair
- ☐ D) CO_2 binds
- ☐ E) subunit dissociation into monomers

5. The Bohr effect explains which of the following:

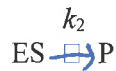
- ☐ A) The tendency to be bored in CHEM 155A
- ☐ B) The observation that decreased pH increases the affinity of Hemoglobin for O_2
- ☐ C) The observation that pH does not affect O_2 binding
- ☒ D) Increased O_2 release to tissue in response to heavy exercise
- ☐ E) Decreased O_2 release to tissue in response to heavy exercise

NAME Key

6. The steady state assumption, as applied to enzyme kinetics, implies:

- A) $K_m = K_D$.
- B) the enzyme is regulated.
- ☒ C) the ES complex is formed and broken down at equivalent rates.
- D) the K_m is equivalent to the cellular substrate concentration.
- E) the maximum velocity occurs when the enzyme is saturated

7. If the assumption that the (rate-limiting) step of the reaction is:



This implies that the overall rate of an enzyme-catalyzed reaction is:

- A) $V = k_2 [P]$
- B) $V = k_2 V_{max}$
- C) $V = k_2 [S][P]$
- D) $V = k_1 + k_2/k_1 [ES]$
- ☒ E) $V = k_2 [ES]$

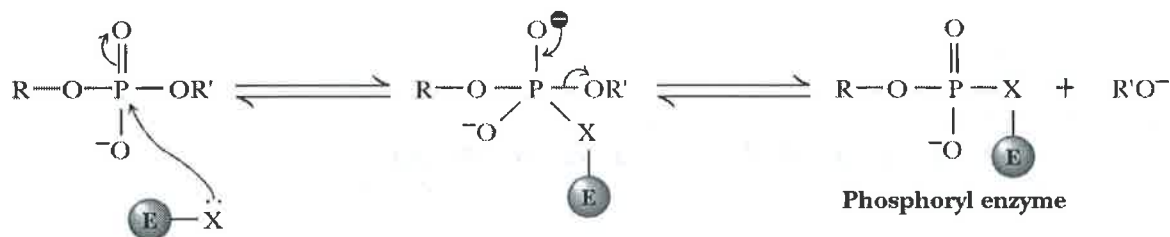
8. If the K_m of an enzyme for substrate A is 0.01 mM and the K_m for substrate B is 3 mM, what can we conclude?

- ☒ A) The enzyme binds stronger to substrate A.
- B) The enzyme binds stronger to substrate B
- C) The catalytic rate would be the same for the 2 substrates
- D) Varying $[S]$ has no effect on V_0 .

9. An inhibitor that binds a different site than the substrate, and affects catalysis but not substrate binding is most likely:

- A) Competitive
- B) Uncompetitive
- C) Mixed
- D) Zombie
- ☒ E) Pure non-competitive

10. The following is an example of what type of catalysis?



- A) Quantum Tunneling
- B) General Base Catalysis
- C) Low Barrier Hydrogen Bonds
- D) Metal Ion Catalysis
- ☒ E) Covalent Catalysis
- F) Zombie apocalypse

11. What is the oxyanion hole found in serine proteases?

- A) A component of the catalytic triad
- ☒ B) A pocket that stabilizes the oxyanion on the tetrahedral intermediate.
- C) A pocket that stabilizes the oxyanion on the acyl-enzyme intermediate.
- D) A pocket that stabilizes the transition state using quantum tunneling.
- E) Where oxyanions criminals are placed if they misbehave.

12. What conditions must exist for quantum tunneling to occur in enzyme catalysis?

- ☒ A) Wavelength of the atoms must be similar to the distance transported
- B) Regular hydrogen bonds must form
- C) Ion pairs must reach across space
- D) There must be a non-zero probability of winning the lottery
- E) Cysteine must be present

NAME

key

Part II – Written Answer – Answer the following questions in the space provided

1. You have discovered a 17 amino peptide that is important in the formation of gastric cancer. The protein is found in the stomach, where the pH is 1.2. You carry out experiments and determine that peptide can form an α -helix.

1 2 3 4 5 6 7 8 9 10 11 12 13
-Ala-Val-Ala-Val-Gln-Ile-Gln-Ala-Asp-Asp-Ala-Val-Gln-Pro-Pro-Trp-Lys

In the protein's native environment (stomach), which amino acids in the sequence would likely form the alpha-helix? How would you predict it to change at pH 7.0? Provide a rationale for your selection

Ala 1 - Gln 13

At pH 7.0 helix might be shorter Ala 1 - Ala 8
Asp 9-10 would deprotonate, the negative side chains would repulse, destabilizing the helix

2. Who would have a higher level of BPG: a person at low altitude or one at high altitude? Explain your reasoning

At high altitude. 2,3-BPG stabilizes the T-state. This lowers the affinity for O_2 , resulting in more O_2 delivered to the O_2 deprived tissues

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3. You have discovered 2 enzyme inhibitors that may cure all known disease. This discovery could make you rich and famous. You carry out kinetic experiments using 50 nM of enzyme. The results from Lineweaver-Burke Plot are as follows:

Units – v $\mu\text{mol}/\text{min}$; $[S]$ – μM

No inhibitor: $1/v = 63.2 (1/[S]) + 1.95 \times 10^4$

Inhibitor A: $1/v = 211.8 (1/[S]) + 1.98 \times 10^4$

Inhibitor B: $1/v = 137.2 (1/[S]) + 4.38 \times 10^4$

- a) Calculate the K_m and V_{\max} for the three experiments.
b) Based on your calculations what type of inhibitor A and B? Provide a rationale for your selection

	<u>K_m</u>	<u>V_{\max}</u>
No inhibitor	3.27×10^{-3}	$5.15 \times 10^{-5} \text{ mol} \cdot \text{min}^{-1}$
Inhibitor A	0.010	$5.05 \times 10^{-5} \text{ mol} \cdot \text{min}^{-1}$
Inhibitor B	3.13×10^{-3}	$2.28 \times 10^{-5} \text{ mol} \cdot \text{min}^{-1}$

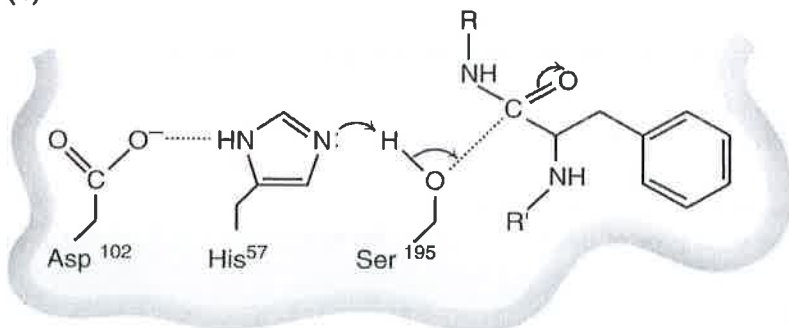
A - competitive K_m increased, V_{\max} unchanged.

B - non-competitive K_m same, V_{\max} decreased.

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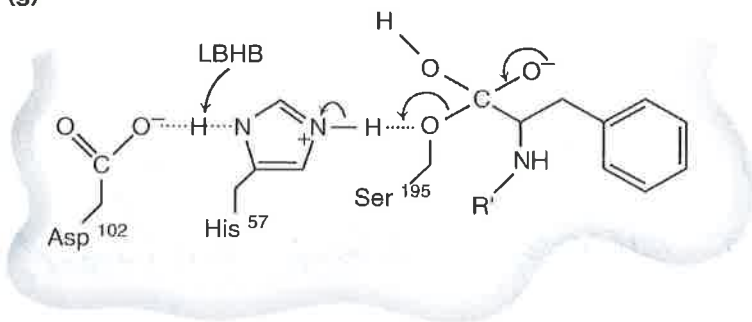
4. For each step of the chymotrypsin catalytic cycle shown below, write a brief description of what is happening and indicate what type of catalysis is occurring.

(b)



His 57 is H-bonded to Asp102. This increases pK_a , making His57 a base.
 His 57 deprotonates Ser 195 - generating a oxy anion nucleophile
 (general base catalysis)
 Nucleophile attacks substrate carbonyl. New bond forms
 (covalent catalysis) - resulting in a tetrahedral (oxy anion) intermediate.

(g)

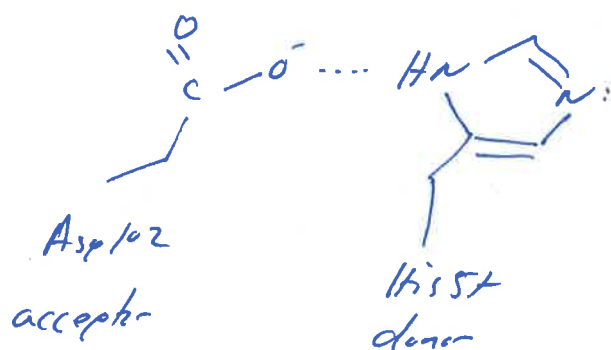


Protonated His 57 pK_a ~ acidic. Forms a LBHB with Asp102
 His 57 donates a proton to Ser 195 (general acid catalysis)
 Tetrahedral intermediate collapses, protonation of Ser 195
 breaks bond linking product to enzyme.
 Catalyst is regenerated.

NAME K+2

5. If you mutate Asp102 to Asn there is a complete loss of enzyme activity. Provide an explanation for this phenomenon

Key to catalysis is a hydrogen bond between Asp102 and His57. The tautomer of His is stabilized, resulting in a very basic pKa value.



Although Asn is similar in size to Asp the amide on Asn can act as a hydrogen bond donor. This means Asn can H-bond with His57, but stabilize the wrong tautomer.

